How to be confident about PID and forehearth control

Forehearth Services has provided professional forehearth training to more than 500 glass plant engineers. As a result, says John McMinn, there are many more forehearths operating at significantly higher production efficiencies than before.

The author was asked recently what was the most common forehearth-related problem affecting production and forehearth efficiency? Without hesitation, the answer was PID. It is estimated that across all industries, 90% of PID values are inappropriately tuned. Unsurprisingly, the glass industry is no exception.

The influence of PID values on forehearth performance is huge, with seemingly small changes in PID parameters producing dramatic changes in forehearth operation.

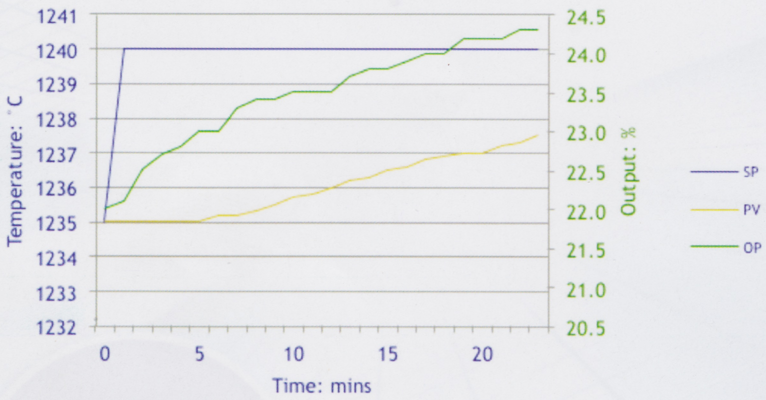


Figure 1: Forehearth response to 5°C SP change.

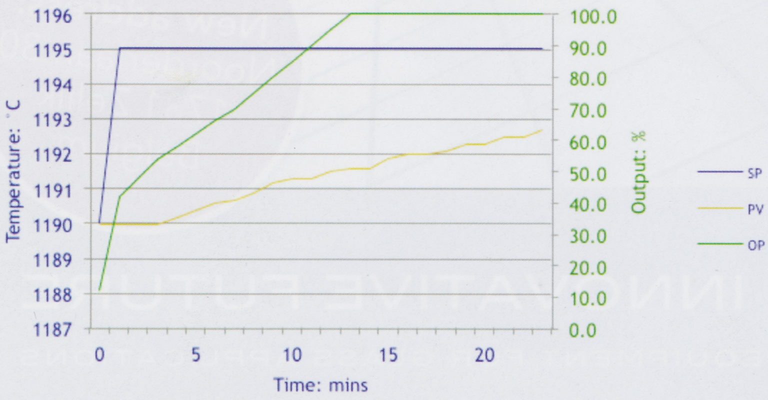


Figure 2: Forehearth response to 5°C SP change.

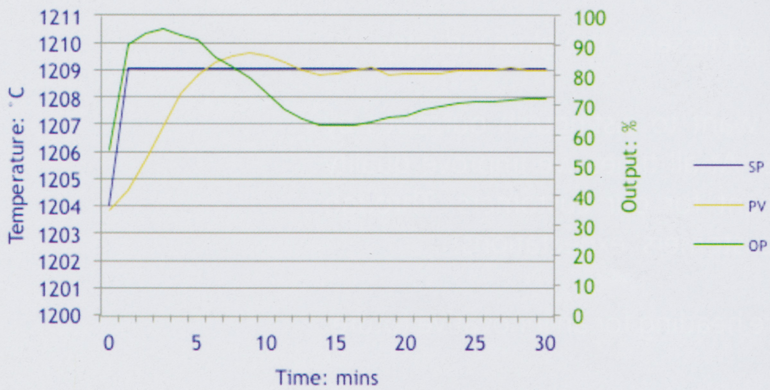


Figure 3: Forehearth response to 5°C SP change.

Consequently, there is a natural reluctance among forehearth engineers and operators to attempt PID tuning. Many of the factories visited by Forehearth Services were still using the same PID values that were installed by the forehearth commissioning engineer. From some of the installations investigated, it would appear that many commissioning engineers could benefit from a training course in PID setting.

FULL EXPLANATION

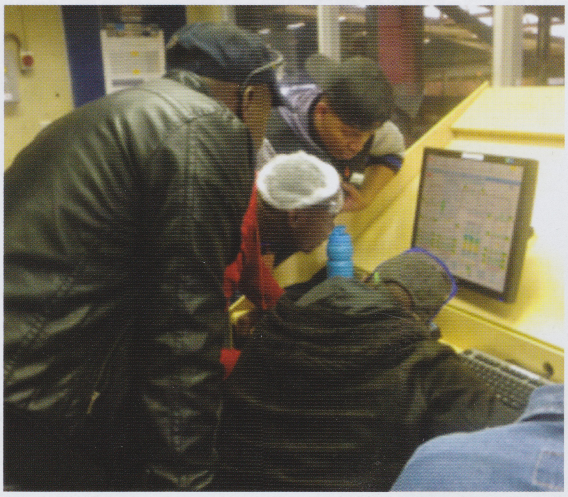
The theoretical sessions of the Forehearth Services training programme include a comprehensive explanation of PID control for forehearths and to complement this, the practical training session focuses on analysing forehearth control loop response to provide the information necessary for tuning and resetting PID values. It is still surprising to learn that many engineers have never accessed the PID values, let alone adjusted any of them. Better to leave the values untouched than to risk production meltdown!

Every year, forehearths are witnessed that have been altered to try to accommodate badly tuned PID values. It is relatively common, for example, to see over-reactive loops that have been partially neutralised by imposing limits on the heating or cooling outputs.

THERMAL STABILITY

Another question frequently raised is how to reduce the time required for the forehearth to achieve thermal stability after a job change. Again, the answer is to ensure the PID values are appropriate and of course, vital operating parameters such as air/gas ratio are correctly calibrated.

A typical example of a badly tuned combustion



PID analysis at Nampak.

loop is shown in figure 1. Taken from a forehearth audit, this example shows that the forehearth is unable to achieve a 5°C increase in setpoint within the standard audit test period of 30 minutes. This is a clear example of inappropriate PID values. The system is unable to achieve the desired glass temperature due to the proportional gain response that produces a 4% increase in combustion output temperature.

Sometimes, despite an effective PID response, the system cannot achieve the desired glass temperature. An example of this is shown in figure 2. This example, also taken from a forehearth audit, shows a reasonably good response, in which the heating output saturates after 12 minutes. Despite the large increase in output and the timescale over which the heating is applied, the glass temperature has increased by less than 3°C.

The most common reason for this response is a de-calibrated air/gas ratio although in the case of the above, it was due to a badly calibrated combustion air control valve. Irrespective of why the system failed to achieve the desired change in glass temperature, a forehearth operating with these conditions could not possibly be expected to react appropriately to achieve and stabilise a new glass temperature profile at job change time.

A fairly well tuned forehearth PID loop is shown in figure 3. In this example, the high initial output response has provided a swift initial glass temperature increase, with only a moderate temperature overshoot of less than 1°C. The reactions of the proportional and integral gains are combining to achieve and maintain the required glass temperature within an acceptable timescale. In short, the PID values used here are those required to ensure the most effective forehearth response to post job change forehearth temperature re-stabilisation.

SENSOR CHOICE

A further complication encountered when analysing loop response is due to the type of sensor used for loop temperature control. Based on a wealth of forehearth audit data, the response is greatly affected by the choice of sensor. Assuming correct PID values and system calibration etc, an immersed thermocouple will typically achieve a 5°C setpoint increase in seven or eight minutes. A radiation pyrometer operating with flint glass will achieve setpoint in four or five minutes and if operating on green or amber glass, the forehearth will 'achieve' setpoint in two minutes.

This apparent link between loop response times and temperature sensor and glass colour is very misleading. There is a vital difference between apparent loop response and real glass temperature change. This is an important topic, covered in detail in the Forehearth Services training course and manuals.

Forehearth Services forehearth audits and technical training demystify PID. The 500 or so glass plant engineers and operators trained have the ability to assess whether or not the control loops are working optimally and the confidence to retune the PID parameters to provide optimal forehearth performance. ■

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